Calculated with respect to the ground level $4p^2\ {}^3p_0$ as zero the newly identified levels are

$$5p\ {}^3D_1 = 216674$$
$$388$$
$${}^3D_2 = 217062$$
$$3907$$
$${}^3D_3 = 220969$$

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13

ON THE MAGNETIC PERTURBATION OF AN ELECTRON BEAM

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A sharp edge of the usual razor blade of hard steel was employed as a specimen for the experiment. The remanence of this specimen was about 10^4 gaussos. A fine electron beam (diameter of the cross-section being 0.05 mm nearly) grazed the edge of the specimen of the maximum gradient of the magnetic field. An electron diffraction pattern here obtained is shown in figure 1. In this figure we see that the diffraction rings are abnormally perturbed. The central spot found in figure 1 was optically 12 times enlarged in order to investigate the perturbation suffered by the incident beam in passing through the magnetic gradient This perturbation is recognizable in figure 2. In this figure we see that a unique incident beam is splitted into many a beam. This singular phenomenon should be elucidated in the present study.

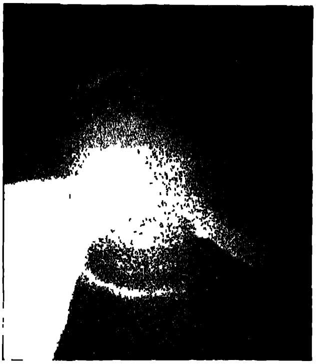

Fig. 1. Diffraction pattern obtained from the edge of permanent magnet. The diffraction rings are perturbed. (Wavelength: 0.0328 Å. Camera-length: 495 mm. Positive enlarged 2.3 times)

It is known that an electron beam spreads in passing through a magnetic field with gradient. As a matter of fact, all the splitted beams found in figure 2

Fig. 2. The central spot in figure 1 is 12 times enlarged. The incident beam is splitted into many a beam.

show the spreading. From this spreading, ΔZ, we can estimate the magnetic gradient $|\partial H_z/\partial Z|$ existing at the edge of the specimen according to the following equation:

$$\Delta Z = e\left|\frac{\partial H_z}{\partial Z}\right| . \Delta X . \frac{\lambda l L}{h} \quad \cdots \quad (1),$$

where e is the electron charge (1.6×10^{-20} emu), ΔX is the diameter of the cross-section of the intact incident beam, λ is the wavelength of the electrons (0.0328)Å, is the magnetic path of the electrons (about one micron), L is the camera length

(495 mm), and h is the Plank's constant (6.6×10^{-27} erg. sec). In figure 2 we measure $\Delta Z/\Delta X \simeq 3$. Therefore, we obtain $|\partial H_z/\partial Z| \approx 10^6$ gauss/cm. This magnetic gradient is steep enough to polarize the electrons according to the Stern-Gerlach's process. The separation between the parallel and the antiparallel electron spin, which results from the Stern-Gerlach's process, is given by replacing ΔX by λ in Eqn. (1). Therefore, the force for this separation is weak as compared with that for the spreading caused by the magnetic gradient so that the former is overwhelmed by the latter. This implies that the spin separation can not *directly* be observed in the present process (1).

Any splitted electron beam observed in figure 2 contains the polarized electrons. As there are many fine zigzag edges in the specimen (figure 3), a re-

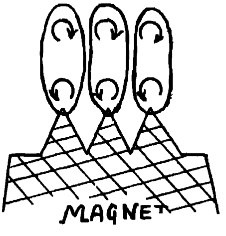

Fig. 3. Any splitted beams in figure 2 contains the polarized electrons. A repulsion occurs between the polarized electrons.

pulsion occurs between the polarized beams, which corresponds to a repulsion between the magnetic moments. In figure 3, the sign of the arrow means the spin directions contained in the polarized beams. In this way the splitting of the electron beams in figure 2 is elucidated as the indirect result of the polarization caused by the behaviour of electron spin.

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